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Progress Report

EVALUATION OF A DOUGLAS-FIR TUSSOCK MOTH POPULATION NEAR AZTEC PEAK, ARIZONA 1967

by

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SUMMARY

An evaluation was made in 1967 of an incipient outbreak of the Douglas-fir tussock moth in the Sierra Ancha mountains of Arizona. Purposes of the evaluation were to assess the suitability of the area for a field test of a virus introduced to control the tussock moth. Populations were examined three times during the season at ten permanent sample points; twice during the larval stage and once in the egg stage. Major findings of these studies are as follows:

1. Larval populations in 1967 were variable, but low at all sample points. The highest levels were encountered in the area north of the Murphy Ranch. Tree damage was insignificant.

2. Fall egg populations indicate that a substantial population increase may occur in 1968, but most of the area under observation will still be at a relatively low level. The heaviest egg population is confined to about 40 acres north of the ranch where the tussock moth may reach outbreak status in 1968. Significant defoliation can be expected in this area.

3. The highest populations are at a level acceptable for a virus test, but occur over too small an area for an adequate experimental design. Populations over the remainder of the area are presently too low for a field test.

4. If the population continues in an upward trend, the infestation may be at a suitable level and size for virus testing in one or two years.

5. Studies should continue in the area in 1968 to provide precise trend data and basic information concerning the mechanisms involved in population fluctuations. This information will be necessary if a test is carried out in the future.

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INTRODUCTION

A major research program is underway to develop a practical means of controlling outbreaks of the Douglas-fir tussock moth, Hemerocampa pseudotsugata McD. by virus sprays. This program is described in a prospectus prepared in 1966 by the Pacific Northwest Forest and Range Experiment Station and Region 6 of the U. S. Forest Service.[1/] Items 1A and 1B of the prospectus define the need for locating a tussock moth infestation of suitable size and physical characteristics where the effectiveness of an artificially applied virus can be tested under field conditions.

At the present time, the tussock moth is generally at a low level throughout most of the West. The only known populations large enough to study are in New Mexico and Arizona. The largest of these, and the one with the most potential as a test area, is in the Sierra Ancha mountains near Aztec Peak in Arizona. It is the site of a former tussock moth outbreak much of which was sprayed with DDT in 1959.

The current population was detected in the late summer of 1966 when very light defoliation in the tops of a few trees was first observed from the air. Further ground checking confirmed that a low tussock moth population was present although tree damage was almost nonexistent. The area was logistically suitable as a test site and seemed to have a low level population that could be a year or two away from an outbreak. For these reasons an evaluation was carried out in 1967 to assess characteristics of the infestation systematically and in analytical terms.

1/ Prospectus for a Joint Research-Administrative Effort to Develop and Test a Method for Using a Nuclear-Polyhedrosis Virus against the Douglas-fir Tussock Moth. Unpublished. Portland, Oregon. March 23, 1966.

OBJECTIVES

Primary objectives of the evaluation were:

1. To determine the value of the area for a test by firmly establishing the level, distribution, and trend of the current tussock moth population.

2. To provide biological data a year or two in advance of treatment in the event the area was used for test purposes.

Secondary objectives that could be met in the normal course of evaluation were:

1. To test and improve newly developed methods of sampling tussock moth larvae and eggs, especially at low population levels.

2. To study the dynamics of a natural tussock moth population through one or more generations.

METHODS

Description of Area

The area of known population is in the vicinity of the Murphy Ranch in the Tonto National Forest (Figure 1). It comprises about 300 acres of mixed conifer type on a shelf at about 7,000 feet elevation. The stand surrounding the ranch is composed of white fir, Douglas-fir, and ponderosa pine. The firs largely predominate near the ranch, but grade progressively into pine to the east and south. A variety of age classes are present with a fairly heavy complement of young white fir and Douglas-fir of a size that can be sampled with poles from the ground. Much of the topography immediately surrounding the ranch is composed of moderate slopes and is accessible by recent logging roads and skid trails. The usable site for test purposes is limited on the north and west by steep slopes and on the south and east by pine type.

Sampling

Populations were estimated by sampling at ten points located approximately 20 chains apart (Fig. 1). At each point 15 fir trees between 25 and 50 feet in height were selected for sampling. These were distributed over an area no larger than about one acre in size. Successive samples during the summer and fall were always taken from the same trees at each point.

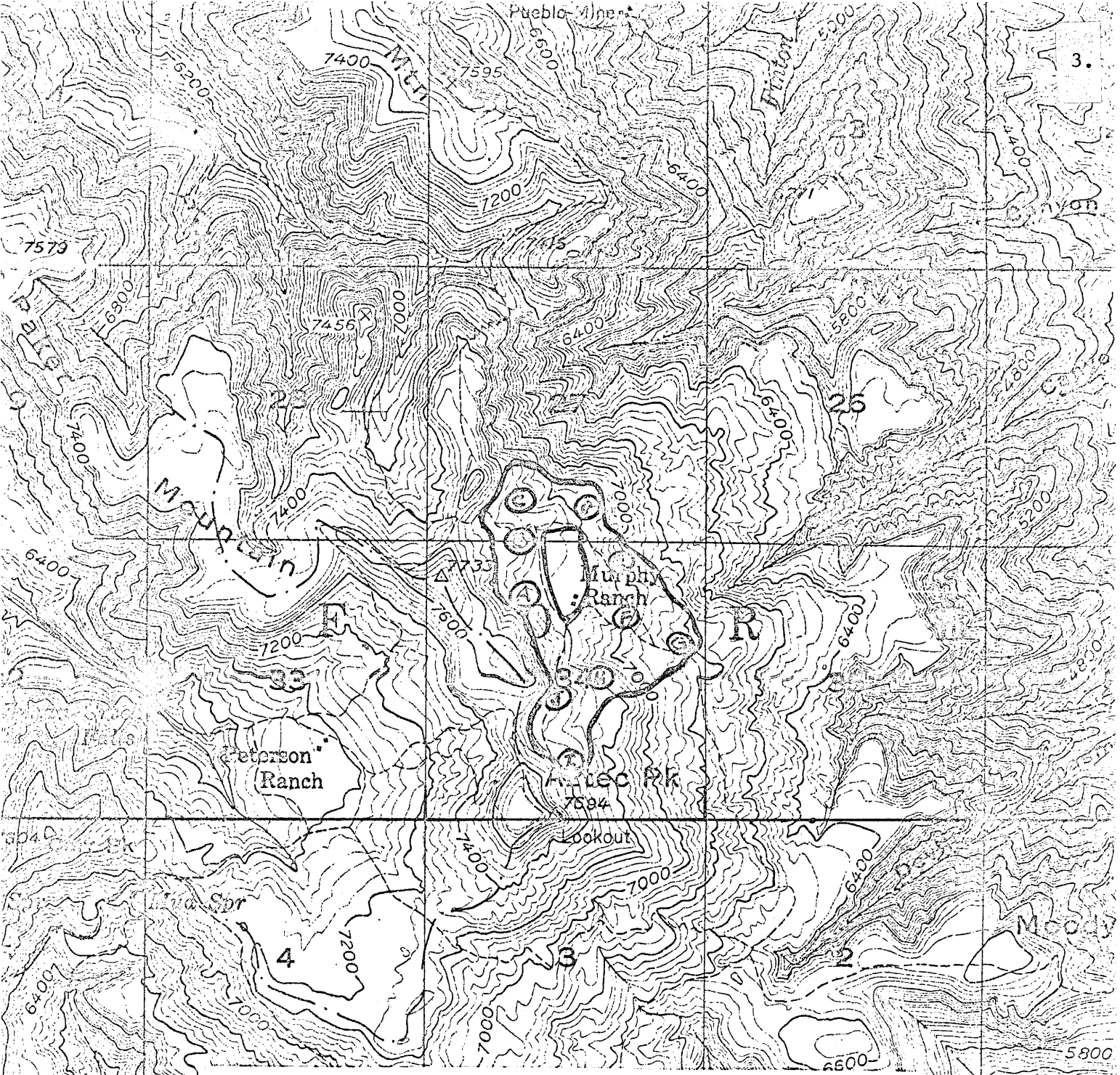

Figure 1. Map of Douglas-fir tussock moth population with location of established sample points. Map is part of T. 6N., R. 14E., Gila County, Arizona.

Scale: 2 inches = 1 mile

Larval populations were estimated by counting all larvae on three 15-24 inch branch tips clipped in a representative manner from the mid-crown of each sample tree. A pole prunner with an attached muslin basket was used to clip sample branches from the tree. Larvae were then dislodged from the branch and collected on a white cloth on the ground where they could be counted. Number of sampled larvae on each branch was adjusted to a fixed unit of branch area of 1000 sq. in. The general procedure for sampling tree foliage and estimating number of larvae is described in detail in a recent progress report.2/

Egg populations were estimated by sampling five whole branches in a representative manner from the entire tree crown. Egg masses were counted on each branch and adjusted to 1000 sq. in. of branch area. Number of eggs were then calculated by multiplying the mean number of egg masses times 160 which is the average number of eggs per mass determined in other studies.2/ This figure may need correction after egg masses from Sierra Ancha have been separated and counted.

RESULTS

Precision of estimate

Sampling precision was usually within 50 percent of the mean when points were analyzed as clusters and a mean and standard error were calculated for the whole area. For individual points the standard error was variable, depending on population level. Degree of precision was directly related to the population level of either larvae or eggs as shown in Figure 2. As expected, sampling precision of eggs was much lower for the same mean than for larvae because of high aggregation of eggs in the egg mass. The same number of larvae can be estimated with much greater precision and fewer samples since they are better distributed through the foliage than are eggs.

In practice, a precise estimate of the population is usually not necessary at very low levels since the magnitude of the error on the numerical scale is also small. As shown in Figure 2, the sampling precision of a larval density over 2.0 insects per 1000 sq. in. was less than 30 percent of the mean which is probably adequate for most population work. Moreover, these results are very similar to previous studies on sampling tussock moth larvae and eggs which tend to confirm the value of the sampling scheme. The same procedures can now confidently be recommended for evaluating other tussock moth populations and the precision of estimate predetermined according to need by adjusting sample size.

2/ Mason, R. R. 1967. Development of Sampling Methods for Natural Populations of the Douglas-fir tussock moth. Progress Report. Pacific NW. Forest and Range Exp. Sta. 55 pp.

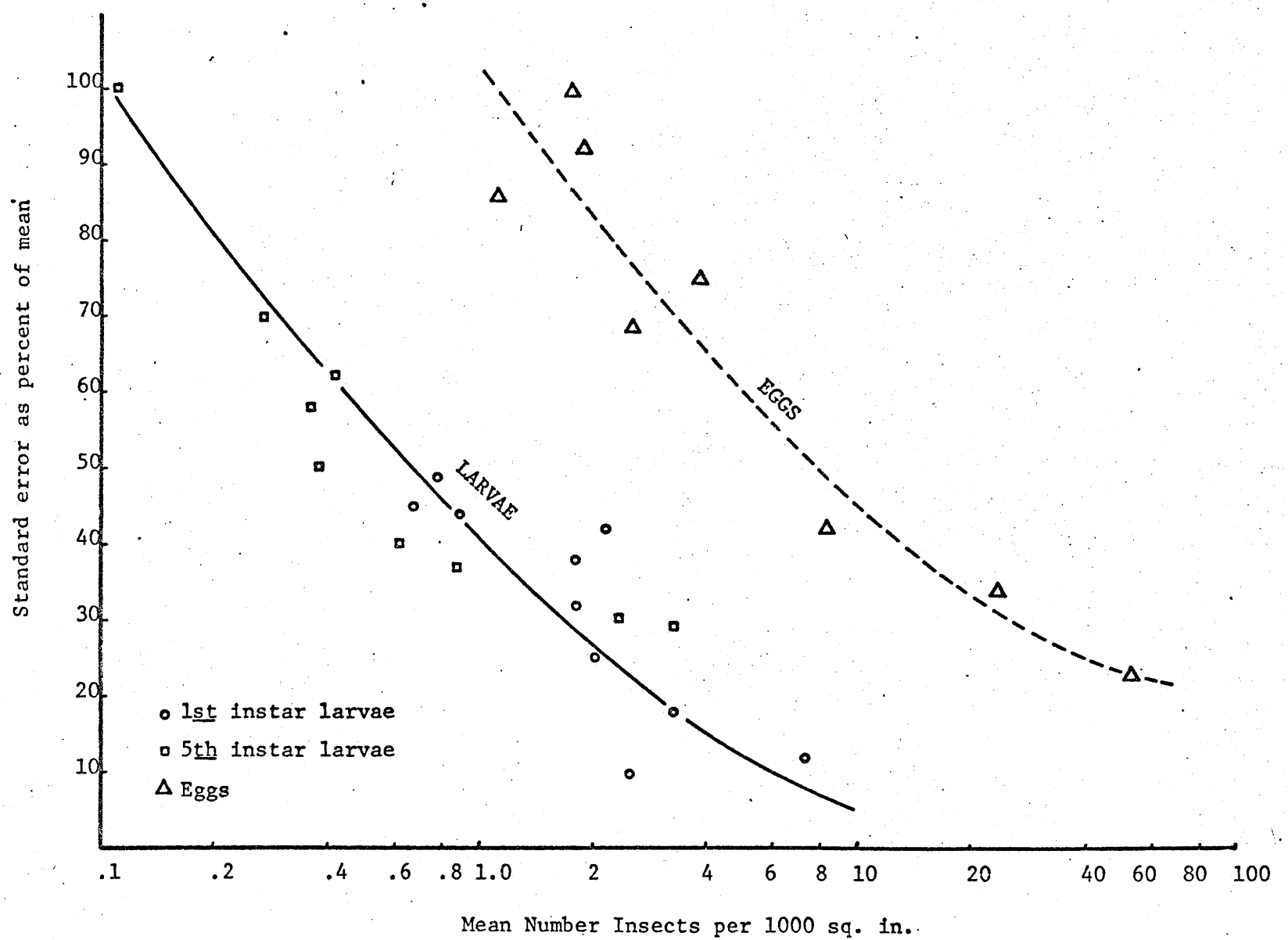

Figure 2. Degree of precision with which larval and egg populations were estimated.

Population levels

Tussock moth populations were estimated three times during the season at each of the ten sample points. Larvae were sampled twice during the summer, once in the first instar and again in the fifth instar; eggs were sampled in the fall after oviposition was nearly complete. These results are presented in Table 1.

Table 1.--Mean number of tussock moth larvae and eggs per 1000 sq. in. of branch area at sample points near Aztec Peak in 1967

Sample point	First instar larvae June 5-8	Fifth instar larvae July 24, 25	Eggs October 4, 5	(Masses in parenthesis)
A	1.82	0.11	3.84	(.024)
B	1.80	0.42	8.32	(.052)
C	7.29	3.28	53.28	(.333)
D	3.29	2.36	23.68	(.148)
E	0.78	0.38	1.76	(.011)
F	2.18	0.62	0	(0)
G	2.04	0.87	2.56	(.016)
H	0.67	0.36	1.12	(.007)
I	0.07	0.27	1.92	(.012)
J	0.89	0	0	(0)
All points	2.08	0.87	9.65	(.060)

Precision of the mean values recorded in Table 1 can be read from the graphs in Figure 2. In general, sample points on the north end of the infestation currently have the highest egg populations. The remainder of the area examined still has a relatively low population.

Based on these data the section with the highest population is represented by points B, C, and D and amounts to about 80 acres. However, no more than 40 acres of this could be classified as "heavy" (>50 insects per 1000 $in.^2$). The remainder of the infestation outlined in Figure 1, excluding the Murphy Ranch, totals about 160 acres, all of which is currently "light" (< 5 insects per 1000 $in.^2$). Total acreage in the whole infestation that could potentially be used for test purposes probably does not exceed 250 acres.

Population trend

Some insight into the probable course of the present population can be gained by comparing the level of first instar larvae in early June with that of the fall egg population. Assuming that percent egg hatch is fairly high in the spring, then the present number of eggs should be indicative of the number of first instar larvae that will appear next year. Unusual mortality of overwintering eggs or newly emerged larvae could distort trend predictions.

In Figure 3 the fall estimate of eggs at each sampling point is plotted over the number of first instar larvae at the same point. These are graphed on a logarithmic scale to observe changes better at low population levels. To illustrate trend rates dash lines are drawn that represent populations in a steady state ($Y = X$) and in exponential growth ($Y = X^2$).

Eight of the ten sample points have an egg population that is either similar or considerably larger than the larval population early in the summer. The points with the largest populations and the smallest sampling error especially show a consistent growth trend that appears almost exponential. Low populations that are a less precise estimate have more variability. In general, the overall trend of the tussock moth seems to be in an upward direction. The population at the north end of the study area particularly, where eggs are heaviest, seems to be rising rapidly. Barring high egg mortality, significant defoliation will inevitable occur in that section in 1968.

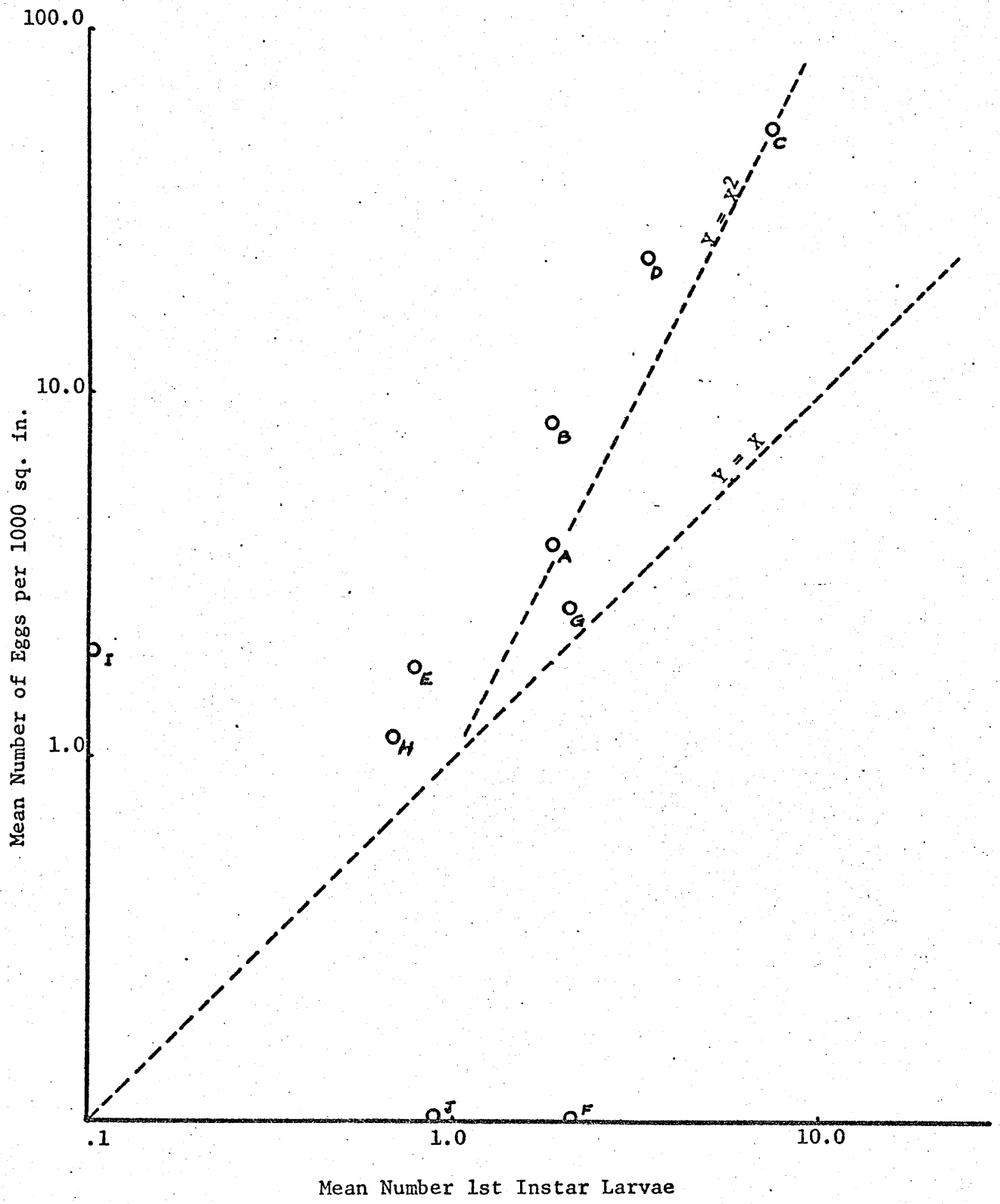

Figure 3. Relationship between number of first instar larvae and subsequent number of eggs at each sample point.

DISCUSSION AND RECOMMENDATIONS

The section of heaviest infestation is the only portion of the area examined where the tussock moth population is high enough to be considered for a virus test in 1968. However, the 40 acres estimated in this section is not large enough to include the necessary treatments and control blocks for field testing the virus in a natural population. The remainder of the area, although of substantial acreage, presently has a population too light for testing. If the upward trend of the population continues, additional area could be suitable for testing within a year or two. Historically, the size of tussock moth populations are variable at the early stage of outbreaks so that defoliation first appears in patches or "hot spots". Adjoining areas probably still have a relatively high level population, only they lag somewhat behind the primary centers. If this is the pattern of development at Sierra Ancha, then the area still has promise as a test site at some future date.

Aside from its value as a potential test area, the site at Sierra Ancha presents an excellent opportunity to study trends of a natural population of the tussock moth. The evaluation studies established in 1967 have already provided additional information on sampling techniques which must be perfected for eventual analysis of virus effectiveness. Also population levels have now been determined at ten points on the site; these should be followed, if possible, for several seasons to gain further insight on regulatory processes operating in tussock moth populations. Lack of continuous and precise data on field populations is a serious shortcoming in our effort to understand tussock moth outbreaks. This problem will continue to handicap our progress until long term trend information becomes available.

Based on evaluation studies in 1967, the following course of action is recommended for 1968:

1. Delay for at least one year any decision to use the Sierra Ancha site for a virus test.

2. Continue to monitor tussock moth populations at the ten established points.

3. Expand some phases of study to gather more precise data on disease, parasites, and predators in a rising population.

4. Survey surrounding area to detect early any incidence of other outbreak centers.

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